

CASE STUDY REPORT

**NTCIP 9004 v01.05**

**City of Phoenix, Arizona**  
**Phoenix Advanced Transportation**  
**Management System**

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**1. PURPOSE OF THE CASE STUDY**

**1-1 INTRODUCTION**

Field deployment of NTCIP-Conforming equipment has begun. State and local Departments of Transportation and their consultants are aware of the interoperability and interchangeability features promised by the NTCIP, and are including references to the NTCIP in their procurement documents. For all but a few, this is their first experience with the NTCIP.

The purpose of this project, sponsored by AASHTO, FHWA, ITE and NEMA, is to prepare a series of case studies that describe the lessons-learned by vendors, agencies, and consultants during three of the early projects that required NTCIP compliance. The objective was to compile an unbiased investigation of each case study that incorporates the perspectives from different implementation positions.

Two Dynamic Message Sign (DMS) projects and one traffic signal control project were selected for this study during 1999. Additional projects may be investigated in FY 2000. The material for these case studies were drawn from interviews with individuals who were directly involved in the NTCIP implementation and from project-related documents such as specifications, test plans, and procurement documents. At least three individuals in different roles, such as agency champion, procurement specification writer, agency field technician and vendor representative was interviewed. The interviews, conducted by individuals familiar with the NTCIP, were structured around a survey prepared for these case study investigations. Whenever possible, relevant project documents for each project are included in that case study report.

This document focuses on the implementation of devices using the NTCIP. It does not attempt to explain the details of the NTCIP. Additional information on the NTCIP, including specific NTCIP standards, is available on the NTCIP Website ([www.ntcip.org](http://www.ntcip.org))<sup>1</sup>.

## 2. THE CASE STUDY

In 1996, the City of Phoenix initiated a project to enhance their traffic signal system. This project included two distinct parts, the replacement of the central traffic control system, and the upgrade and purchase of additional traffic signal controllers. The NTCIP was specified as the communications protocol of choice for both. The central system (termed Phoenix Advanced Traffic Management System or Phoenix ATMS) was also required to control additional field devices, however, without the requirement to utilize the NTCIP communications protocol.

The project schedule is summarized in Table 1. Phase 3 (of four) was underway when the interview was conducted.

- Phase 1: Phoenix ATMS developed to control AB 3418<sup>2</sup>-compliant signal controllers to be installed at 57 downtown intersections<sup>3</sup>.
- Phase 2: Phoenix ATMS development continued. Second-by-second communications and NTCIP, download/upload capabilities were added. VENDOR traffic signal controllers were integrated.
- Phase 3: Integration continued. Second-by-second communications and upload/download functionality to be added to allow communication with controllers from a second vendor.
- Phase 4: Bids to be solicited for an additional set of signal controllers from a third vendor.

Traffic signal controllers at more than 1000 signalized intersections and approximately 350 traffic cabinets will be replaced in a staged effort over multiple years and purchases. The City is transitioning from the existing UTCS-based system installed in the 1970s, to a new distributed control system. With the new system, local intersection control will be provided through timing plans resident at the traffic signal controller that are selected primarily from time-of-day (TOD) schedules. Existing NEMA TS 1 traffic signal controllers will be replaced with NEMA TS 2 signal controllers capable of Type 1 and Type 2 actuated configurations from a single controller unit. The communications media consists of several half-duplex 1200-baud leased lines and two full-duplex 9600-baud fiber optic channels. The existing and new devices are described in Table A-1<sup>4</sup>. The Phoenix ATMS will also control CCTV cameras, ramp meter controllers and variable message signs (VMS).

This case study focuses on two NTCIP-compliant components of that project. The VENDOR and SYSTEM INTEGRATOR for this study were Econolite and TransCore, respectively. Another vendor, PEEK Traffic Systems, was added to the project later, but integration of these new controllers was not finished when the interviews were conducted. The City of Phoenix also plans to purchase approximately 200 additional field controllers from a third vendor.

The objectives of the AGENCY in implementing this project were:

- 1 The White Paper "Understanding the NTCIP Class Profiles from an End User's Perspective," prepared by the NTCIP Profiles Working Group is an excellent example.
- 2 California Assembly Bill 3418 (AB 3418) requires all new or upgraded traffic signal controllers installed in California after January 1, 1996, to incorporate a standard communications protocol. The protocol behind AB 3418 is considered the precursor to the NTCIP Suite of Protocols containing definitions for the communications within a multidrop environment and a set of fixed communications messages.
- 3 This was due to the opening of the ballpark stadium and availability of the AB3418-compliant controllers. The development of a device driver for a static protocol was much faster than for a highly flexible protocol such as the full NTCIP.
- 4 See Annex A of this report

- To create a system that will allow traffic signal controllers to be procured from multiple vendors without the need to develop a device driver for every controller model.
- To replace the mainframe-based central system with a modern PC-based system to ensure that the system can be upgraded in the future.
- To cover the city with one control and monitoring central system (the first system only covered 480 of the existing 820 signal controllers).
- To implement distributed intersection control technology within the city in order to reduce the effects of communications failures.

The SYSTEM INTEGRATOR's goal was to facilitate the development and acceptance of the NTCIP by demonstrating its feasibility within an implementation.

This project is one of the first NTCIP deployments to use equipment from more than one vendor<sup>5</sup>.

**Table 1: Project Timeline**

AGENCY	VENDOR	NTCIP Standards Status	Date
Feasibility Study Development			1993
Began writing RFP			7/ 94
RFP published			1/ 96
Proposals due			3/ 96
Contract Award	Contract Awarded		9/96
		NTCIP Standards approved (TS 3.2, TS 3.3)	5/97
		NTCIP Standards approved (TS 3.4, TS 3.5)	11/96
Phase 1 initiated - (development of Phoenix ATMS and implementation of VENDOR traffic signal controllers, AB 3418)			12/96
		NTCIP Standards published (TS 3.1, TS 3.2, TS 3.3, TS 3.4, TS 3.5)	1/97
		Modifications to TS 3.2, TS 3.3 and TS 3.4 published as Recommended Technical Revisions	5/97
Phase 1 completed	Phoenix ATMS installed to control 57 signal controllers in the downtown area using the AB 3418 protocol		8/97
Phase 2 initiated (NTCIP)			12/97
		Additional amendments recommended and incorporated with previous Technical Revisions (i.e., OER, time differential, dynObj Table)	11/98
Phase 2 completed			12/99

<sup>5</sup> Ablett, Matthew; "NTCIP Lessons or Making the NTCIP Work", TransCore, 1998.

AGENCY	VENDOR	NTCIP Standards Status	Date
			(expected)
Phase 3 initiated (Second vendor)			Not yet initiated
Phase 3 completed			Not yet completed
Phase 4 initiated			Not yet initiated

### 3. PROJECT PROCUREMENT

#### 3-1 PRE-QUALIFICATION

The Prequalification RFP for the Traffic Signal Controllers<sup>6</sup> was published in January 1996; proposals were due in March 1996. Proposers were required to supply the AGENCY with one complete controller assembly configured for testing with the new traffic signal system. These signal controllers were required to comply with the NEMA TS 2 specification. The AGENCY required the VENDOR to upgrade the controllers to comply with the final version(s) of the NTCIP. The AGENCY received one (1) proposal for the controller upgrade in January 1996.

No pre-qualification was required for the Phoenix ATMS.

#### 3-2 ADVERTISEMENT / REQUEST FOR PROPOSAL(RFP)

Because only the VENDOR responded to the pre-qualification RFP, only they were eligible to respond to the Invitation to Bid<sup>7</sup> (the actual RFP) for the traffic signal controller upgrade project. The vendor selected for Phase 3 of this project also had to meet the requirements stated in the IFB, and was required to use the same objects supported in the Phoenix ATMS.

The Phoenix ATMS RFP was published in January 1996. Proposal responses were due in March 1996. The bid and award procedure for the implementation of the Phoenix ATMS consisted of a two-stage submittal process. In the first stage, contractors submitted a functional proposal without a cost estimate. These proposals were essentially a technical response to the Phoenix ATMS RFP<sup>8</sup> and a statement of qualifications. Six (6) proposals were received for the Phoenix ATMS<sup>9</sup>.

#### 3-3 SELECTION & AWARD

The only VENDOR to respond to the RFP for the traffic signal controllers was selected.

Two of the 'Phoenix ATMS'-respondents were disqualified because of non-compliance with the required proposal format. The remaining four system integrators were invited to submit an amended final Proposal. The AGENCY selected the SYSTEM INTEGRATOR from this group of proposals based on qualifications, experience, and thoroughness of the proposal. A scope of services and a price was

<sup>6</sup> See Annex A

<sup>7</sup> See Annex C

<sup>8</sup> See Annex F

<sup>9</sup> NET, Gardner+ CompuTran; Holmes&Narver [+ Sonic]; TransCore + Econolite as well as 2 other teams (disqualified and not named here)

negotiated with that SYSTEM INTEGRATOR. The requirements specified within the RFP and the proposal responses were amended during the contract negotiations with a “supplementary conditions” clause because of actual and future anticipated modifications to the NTCIP standards.

The SYSTEM INTEGRATOR and VENDOR for both the central system and traffic signal controller procurements were selected because they were the low bidders. Selection of the second vendor was based on low bid as well as the AGENCY’s desire to integrate different equipment into the system.

#### 4. SPECIFICATIONS

The AGENCY learned about the NTCIP and made the decision to specify it during development of a feasibility study. At that time (December 1993) the relevant NTCIP standards were in a very early draft form. The AGENCY understood that these standards could, and most likely would, change.

The plans and specifications, the functional specification and the RFP for the controller upgrade were developed by the AGENCY without outside assistance. The traffic signal control equipment VENDOR was required to identify any vendor-specific standard NTCIP object ranges<sup>10</sup> as part of the RFP response, and any object definitions to be used in addition to the standard mandatory Conformance Groups and mandatory objects

The Phoenix ATMS (central system) hardware specifications were developed in conjunction with the software and NTCIP portions of the specifications. The hardware specifications included several different platform choices. Although the AGENCY felt its staff had the capability to assemble the functional specifications for the Phoenix ATMS, the AGENCY needed assistance in certain areas. Consequently, some parts of the specifications were developed jointly by an Information Technology specialist firm and a Communications Infrastructure specialist firm.

According to the specifications, the VENDOR and SYSTEM INTEGRATOR were required to provide upgrades to the signal control system and to the field controllers for a period of 36 months following acceptance of the deployed system. The VENDOR and SYSTEM INTEGRATOR were also required to provide add-on (or on-call) services to address changes in the NTCIP suite of protocols following system acceptance and the 36-month warranty period. The specification wording aside, both the VENDOR and the SYSTEM INTEGRATOR were committed to work with the AGENCY to provide a working implementation of the NTCIP. This commitment included overcoming problems and inconsistencies within the standards, and modifying the implementation if the standards were changed during the course of the project.

The actual wording within the “IFB for Traffic Signal Controller” were indicated in Section 2.0 (Scope), Item 4, heading N<sup>11</sup>:

*The successful bidder shall provide a software update(s) for the controller units based on an agreed upon or final revision of the NTCIP protocol. In addition, the successful bidder shall provide the city with all information identifying manufacturer specific features and functions beyond those specified and required by the NTCIP definition.*

The AGENCY considers the RFPs used for this project satisfactory at the time they were developed, and the process used to develop the specifications was generally effective. However, the AGENCY indicated that this specification would be inappropriate for any new purchase. The AGENCY anticipated modifications to the NTCIP suite of protocols during the project. Instead of spelling out the NTCIP object definitions, the RFP described a framework-type specification indicating the functional requirements for

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<sup>10</sup> See Annex A, Table A-3 of this report

<sup>11</sup> See Annex B of this report

the central system and the traffic signal controllers. Consequently, the protocols described for this project was much less specific than they otherwise would have been.

Early in the project, it was determined that the traffic signal controllers at 57 downtown intersections and the Phoenix ATMS had to be installed prior to the opening of the downtown baseball stadium. A fully NTCIP compliant system could not be implemented to meet this deadline. There was not enough time to modify the signal controller and ATMS software to support SNMP (see the discussion below). Fortunately, the SYSTEM INTEGRATOR and VENDOR determined that they could meet this deadline by implementing the Californian AB3418 protocol in these 57 signal controllers and the ATMS. These signal controllers and the ATMS were later upgraded to meet NTCIP standards.

#### 4-1 PROJECT-RELATED NTCIP STANDARDS STATUS

The NTCIP standards relevant to this project are shown in the table below.

**Table 2: NTCIP-Related Standards & Specifications for the “Phoenix ATMS” Implementation**

Standard	Description
AB 3418	The State of California passed a law that requires all new traffic signal controllers implemented in the State of California after January 1, 1996 to comply with the standard protocol defined in Assembly Bill 3418 (AB 3418). AB 3418 incorporates concepts of the NTCIP, but pre-defines a set of “dynamic objects” <sup>12</sup> .
<i>VERY early Draft Standard</i>	<i>May 5, 1995 NTCIP - Working Draft marked “For Committee Reference Only”<sup>13</sup></i>
NEMA TS 3.2 1996 and Amendment 1	Simple Transportation Management Framework (STMF) Conformance Level 2 <sup>14</sup> .
NEMA TS 3.3 1996 and Amendment 1	Class B Profile
NEMA TS 3.4 1996 and Amendment 1	Global Object Definitions
NEMA TS 3.5–1996	NTCIP Actuated Signal Controller Object Definitions

<sup>12</sup> The concepts of dynamic objects are defined in TS 3.2-1996 and were amended in TS 3.2-1996 Amendment 1. A dynamic object provides a means for related managed objects to be operated on as a group. The goal is to minimize the bandwidth requirements when communicating frequently requested sets of objects between a management station and remote devices.

<sup>13</sup> This “very early draft NTCIP Standard” is shown in italics to emphasize the influence this draft had on the development of the NTCIP specifications, even though it was not the basis for the implementation of this system.

<sup>14</sup> Initially, only STMP (Conformance Level 1 of the published TS 3.2-1996) was to be implemented. However, changes in the standard required the support of SNMP; essentially requiring conformance level 2 to be implemented.

In the early stages of the project, the AGENCY attended NTCIP-related working group (WG) meetings and had a very good understanding of the protocol and their implications. The AGENCY referred to the May 5, 1995 NTCIP - Working Draft marked "For Committee Reference Only" during the specification development. This very early version of the NTCIP standard was still organized in one document and it included only object definitions for traffic signal control<sup>15</sup>. The VENDOR began work on the project using draft standards<sup>16</sup> and subsequent Technical Revisions<sup>17</sup>.

There were several significant changes in the NTCIP that impacted this project. NTCIP TS 3.3 was approved as a NEMA Standard in May 1996. This version of TS 3.3 required the use of STMP<sup>18</sup>; the use of SNMP<sup>19</sup> was optional. In May 1997, modifications to TS 3.2, and to TS 3.3 were published as Recommended Technical Revisions, which reversed the requirements for SNMP and STMP. Consequently, both central and field device codes were re-written. While this did not result in a change order to the contract, it did result in increased costs.

## 5. NTCIP FUNCTIONS AND FEATURES

This section discusses the NTCIP functions and features implemented. NTCIP Conformance Groups and Optional Object Definitions are listed in ANNEX A. Additionally, a number of proprietary objects to address special functions and the once-per-second communications requirement were created by the VENDOR and implemented within the ATMS and the signal controllers.

### 5-1 OBJECTS & CONFORMANCE GROUPS

All of the controllers integrated into the system for this project are "NTCIP-compliant". This implementation conforms to "Conformance Level 2" as defined in Amendment 1 of TS 3.2-1996<sup>20</sup>. SNMP could not be used because of bandwidth limitations and because it would not support once-per-second control

The specifications did not define the objects or conformance groups to be implemented. During the course of the project, and after consulting with and agreement from the City of Phoenix, VENDOR and SYSTEMS INTEGRATOR agreed on a set of object definitions to be implemented.

The list of standard objects implemented for this project is included in Table A-2<sup>21</sup>; Table A-3 shows the object value ranges supported. This object definition set included most of the objects defined within the mandatory and optional conformance groups of TS 3.4-1996 and TS 3.5-1996. All optional data elements of the conformance groups were implemented. Proprietary objects were implemented in order to address several functional requirements that were not provided by the standard object definitions. These proprietary objects addressed some optional conformance group functionality differently than defined in the NTCIP standards.

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<sup>15</sup> This version also included concepts of the X.25-format (a network layer protocol) instead of the Internet Protocol (IP), which was specified in later versions of the NTCIP standards. However, no network protocol was used in this implementation.

<sup>16</sup> TS 3.1, 3.2, 3.3 (4-17-96), TS 3.4, TS 3.5 (7-13-96).

<sup>17</sup> The Amendments to TS 3.2, TS 3.3, TS 3.4 and TS 3.5 were approved in 1998.

<sup>18</sup> Simple Transportation Management Framework (STMF) describes the organization of the information within devices and the methods of retrieving or modifying any information within the device. STMF also explains how to generate and utilize computer readable information organization descriptions.

<sup>19</sup> Simple Network Management Protocol - A communications protocol developed by the IETF (define), used for configuration and monitoring of network devices.

<sup>20</sup> Conformance Level 1 requires support of SNMP, while Conformance Level 2 additionally requires the support of STMP.

<sup>21</sup> See Annex A

The proprietary objects also provided additional functions to the mandatory and optional conformance groups as extensions to the standard tables. The VENDOR added so-called “block objects” for database management<sup>22 23</sup>. The SYSTEM INTEGRATOR required status objects such as a “transition/offset seeking” object and the download/upload feature.

The data elements to control these features were developed by the VENDOR. The AGENCY had considered developing its own objects to address these functions but decided against it. The unique object identifiers (OIDs) for these data elements controlling the non-standardized features are located at the VENDOR’s NEMA node address. The AGENCY has the right to re-use the VENDOR-provided MIB for future contracts within the City<sup>24</sup>. These non-standard features will be used in future applications for the AGENCY, as well as for future implementations by the SYSTEM INTEGRATOR and by the VENDOR<sup>25</sup>.

### 5-2 INTERCHANGEABILITY & INTEROPERABILITY

This system provides interoperability among traffic controllers manufactured by different vendors. At the time of the interview, devices from two vendors were being integrated into the system. The AGENCY anticipates the addition of equipment from a third vendor during Phase 4.

Interchangeability is being achieved to some degree. In part, because the AGENCY developed an agency-specific set of dynamic objects that are used to populate some of the 13 dynamic objects. These objects are setup using the STMP-defined mechanism<sup>26</sup>.

### 5-3 THE LEARNING CURVE

The AGENCY staff had participated actively in the development of early NTCIP versions, and was very knowledgeable about those versions. Work assignments limited their participation in the development of later NTCIP versions. Consequently, their knowledge of later NTCIP versions was limited.

The VENDOR continues to be an active participant in the development of all versions of the NTCIP documents.

#### Definitions

**Interchangeability:** the capability to exchange devices of the same device type (e.g., a signal controller from different vendors) without changes to the software beyond updating the appropriate parameters and variables . Some non-standard functions and features might not be available.

**Interoperability:** the capability to operate devices from different manufacturers, or different device types (e.g., signal controllers and VMS) on the same communications wire/channel.

<sup>22</sup> Database management is one of the most important features within a field device. Within a signal controller, manipulating several data elements as a group is critical since the contents are interrelated. Within the NTCIP, there is a standardized mechanism to achieve this, but the implementation provided an additional proprietary mechanism using “block objects” . This is a mechanism where objects are defined using the MIB OBJECT TYPE Macro, but where the value of an object contains a proprietary “message” . These “message” setups are such that each byte, or bit within a byte, or several bytes have a particular meaning. This setup is very similar to the messages used in traditional traffic signal communications protocols.

<sup>23</sup> The “block objects” are specific to each vendor, and each vendor’s controller uses a different set of “block objects.” This means that the central system software must be changed every time a new controller is being added to the system.

<sup>24</sup> Locating object OIDs under the vendor’s node is appropriate and feasible. However, if an agency requires the development of ‘special’ objects and/or entire MIBs, it may be more feasible to place them under an agency node to ensure that the control of the object remains with the agency. If objects are under the vendor’s node, the AGENCY might need an agreement with the VENDOR to maintain the objects until both sides agree to dismiss them.

<sup>25</sup> The VENDOR and SYSTEM INTEGRATOR used the same software for another implementation.

<sup>26</sup> The STMP mechanism is as defined in TS 3.2-1996, not as modified in TS 3.2 Amendment 1.

Therefore, they were very knowledgeable about the objects, their meaning and interpretation. The VENDOR's continued participation on these NTCIP Working Groups was valuable in another respect. Implementation and interpretation issues that arose during this project were discussed during the course of the Standards development. These discussions contributed to the development of the Amendments <sup>27</sup>.

The SYSTEM INTEGRATOR has significant experience develop device drivers to communicate with various proprietary protocols. They were very aware of the emerging NTCIP suite of protocols, and reviewed and had commented on various standards. During the development of the central system, the SYSTEM INTEGRATOR used Internet pages and several books to learn about ASN.1, HDLC <sup>28</sup> and SNMP in addition to the NTCIP Guide (of 1995) and the NTCIP standards publications.

## 6. TESTING COMPLIANCE

The RFP defined NTCIP compliance in a very general way <sup>29</sup>. During the project, the VENDOR defined a set of objects the AGENCY, VENDOR and SYSTEM INTEGRATOR agreed would become the "de-facto" compliance statement <sup>30</sup>.

The AGENCY was satisfied with the testing process. The SYSTEM INTEGRATOR and the VENDOR developed the software code independently, and began integration testing after testing of the individual components was completed. The VENDOR and the SYSTEM INTEGRATOR developed the testing procedures collaboratively. The process was essentially an informal exchange of information between the VENDOR and SYSTEM INTEGRATOR where in the SYSTEM INTEGRATOR and the VENDOR discussed and worked out problems as they were discovered. In most cases, problems resulted from interpretation of the standards rather than from bad frame constructs. Textbooks and the Exerciser were used to resolve frame construction issues. This process worked well and contributed to the development of an integrated system/product <sup>31</sup>.

### 6-1 TESTING TOOLS

The NTCIP Exerciser was not available with the RFP was developed, and consequently was not required within the specifications, but it was used for certain testing procedures. No other testing procedures and tools were defined or described in the RFP.

The VENDOR conducted compliance testing using several different tools, including DataScan, a 'GET NEXT' tester and a 'suitcase tester'. The VENDOR designed the 'GET NEXT' tester, which automatically sequences through all objects, and the 'suitcase tester' <sup>32</sup>, which uses dynamic objects to read signal indications, set parameters, and to read or set other objects. The suitcase tester was also used to test non-standard NTCIP functionality.

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<sup>27</sup> Errors and inconsistencies identified by the VENDOR during software development were recorded and presented to the appropriate NTCIP WGs. The VENDORS recommendations were incorporated in Amendment 1 of TS 3.2-1996 and of TS 3.4-1996. The VENDOR and the SYSTEM INTEGRATOR made the appropriate modifications to ensure a successful implementation.

<sup>28</sup> HDLC – High-level Data Link Control = Data Link Layer protocol

<sup>29</sup> See Annex B, Scope, Item 2, Bullet N.

<sup>30</sup> This does not necessarily mean that every implementation can, or should, implement all of the propriety objects used in this implementation. The interview did not reveal whether the system could be operated without using these proprietary objects.

<sup>31</sup> Leaving it up to the VENDOR and SYSTEM INTEGRATOR could lead to problems when other devices or device types are being added to the system. The interpretation of the NTCIP has to be unambiguous to guarantee that systems can provide interoperability and interchangeability.

<sup>32</sup> A 'suitcase tester' is a testing tool contained in a briefcase or suitcase for portability.

The VENDOR used the NTCIP Exerciser when questions related to frame constructs arose. The VENDOR and the SYSTEM INTEGRATOR compared the frames generated by the NTCIP Exerciser to the ones they developed. The NTCIP Exerciser was also used during development of the testing tools mentioned above.

The VENDOR chose to develop their own testing tools because the NTCIP Exerciser did not meet their needs. They needed a more sophisticated testing tool with a better user interface. At that stage, the setup and the code (software) needed work. The VENDOR found it far easier to form frames manually than to use the Exerciser.

The AGENCY plans to purchase and use a Line Analyzer to verify selected bit/byte patterns to ensure that future vendors interpret the NTCIP the same way the VENDOR and SYSTEM INTEGRATOR have for this project.

At the time of the interview, acceptance testing had not yet been performed.

## 7. USING THE NTCIP

The AGENCY, SYSTEM INTEGRATOR and VENDOR representatives were asked to briefly describe their "NTCIP experience".

### 7-1 FROM THE AGENCY'S PERSPECTIVE

The AGENCY described their experience "on the bleeding/leading edge" as painful but very interesting. From the AGENCY perspective, the standards were not specific enough to provide a "standard" implementation. For example, all devices added to the system require proprietary items such as "block objects" and upload/download mechanisms. These proprietary objects are likely to be different for each vendor's equipment.

The AGENCY learned of the NTCIP while developing the feasibility study. While this study did not mention the NTCIP, the AGENCY decided to implement an NTCIP compliant system at that time. The AGENCY was not comfortable specifying NTCIP in the RFP because of potential changes in the standards during and after the project. Instead, the AGENCY decided to use 'framework-type' terminology and required a commitment by the VENDOR and SYSTEM IMPLEMENTOR to ensure a successful implementation. Once the RFP was released and the negotiation was concluded successfully, the implementation of the NTCIP proceeded as expected (which does not mean that there were no problems).

The AGENCY, aware that the NTCIP protocols were in the draft standard stage, anticipated some changes. The AGENCY's primary concern was that the cost of addressing dramatic changes in the NTCIP would exceed the budget. AGENCY staff were also concerned the download time requirement for database contents would increase dramatically.

The available NTCIP Standards address the AGENCY's existing and planned communications infrastructure. In hindsight, the AGENCY's main objective of achieving interoperability<sup>33</sup> among controllers was realistic and has been achieved. The AGENCY was also able to reduce the number of proprietary objects by defining and requiring the use of specific dynamic object setups in each controller. While it would have been much easier to implement a proprietary protocol, this project helped to advance the standardization effort. The next implementation of the NTCIP should be even smoother. The project, for example, requires another round of software upgrades/revisions that will not be required for later implementations.

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<sup>33</sup> Interchangeability was dropped after it became clear that each vendor would use proprietary objects to achieve some functionalities.

## 7-2 FROM THE VENDOR'S PERSPECTIVE

The VENDOR was committed to the implementation of the NTCIP, although they expected interface issues to arise from the onset of the project. The VENDOR's primary concern in implementing the NTCIP was bandwidth availability. The NTCIP Class B protocol, designed for use with slower communications links, requires more overhead than most of the proprietary protocols in use today. This made it unlikely it would be possible to maintain the same polling cycle time with the same number of controllers per channel and the same data rate. While the VENDOR developed Upload/Download functionality (block objects) to overcome some of the limitations of the 1200 bps communications rate, dependence on the use of these proprietary objects runs counter to the objective of the NTCIP. The number of controllers on each communication line dropped from 8 controllers (using the proprietary protocol) to 4 controllers (using the NTCIP). However, this fact was known at the on-set of the project.

While the level of effort required to implement the NTCIP was much higher than anticipated, the implementation itself went smoother than anticipated.

The VENDOR encountered errors and problems with the balloted standards. In particular, there were errors in the NEMA PER<sup>34</sup> encoding, dynamic objects were poorly defined<sup>35</sup>, and the design of the upload/download mechanism for the database<sup>36</sup> was not as efficient and clear as it could have been.<sup>37</sup>

## 7-3 FROM THE SYSTEM INTEGRATOR'S PERSPECTIVE

The SYSTEM INTEGRATOR saw the concern trying to implement evolving standards realized. However, due to the commitment to ensure a successful implementation, changes and modifications were implemented.

Other concerns included:

- a) The overhead associated with SNMP and usage of standard NTCIP object definitions prohibited communications over 1200 bps communications lines (even 9600 bps) proved inconvenient. To work around this, a great deal of work was required (development of specific block objects), and it led to the decrease of the number of controllers per communications channel.
- b) The standard object definition sets (TS 3.4 and TS 3.5) did not support all the operations of the controllers due to proprietary features. This affected virtually every group of objects within TS 3.5 and led to the creation and implementation of proprietary (VENDOR) MIBs, which will require an adjustment of the software for each controller type.

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<sup>34</sup> Packed Encoding Rules (PER) was developed for use on low bandwidth communications links, as specified in NEMA TS-3.2. In the later version "TS 3.2-1996 - Amendment 1" these encoding rules were renamed Octet Encoding Rules (OER) because, unbeknownst to each other, the International Standards Organization (ISO) also developed a set of encoding rules they also referred to as PER.

<sup>35</sup> Author's Note: The dynamic objects were not as "poorly designed" as a comparison between the first version and the version within Amendment 1 might indicate. The DynObj table was split in two, because it was felt that there would only be one owner of a dynObj. Additionally, some objects that might have been queried using SNMP but contain the STMP dynObj values have been deleted.

<sup>36</sup> See TS 3.4-1996 under Database Management Conformance Group, and TS 3.2-Amendment 1 under Database Management Conformance Group.

<sup>37</sup> Author's Note: These issues have been addressed in Amendment 1 of TS 3.2 (STMF), TS 3.3 (Class B Profile) and TS 3.4 (Global Object Definitions).

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## 8. LESSONS LEARNED

### 8-1 FOR AGENCIES

During the interviews, the following recommendations were made for an AGENCY preparing for an implementation:

- Gain a thorough understanding of the NTCIP <sup>38</sup>.
- Consider hiring a knowledgeable consultant to guide NTCIP implementation
- Understand the interchangeability and interoperability effects of NTCIP.
- Have realistic objectives and goals.
- Provide a definition of "NTCIP-compliance" in RFPs. No "one-liners" requiring NTCIP compliance.
- Include the latest versions of NTCIP standards in your NTCIP specifications.

### 8-2 FOR VENDORS / SYSTEM INTEGRATORS

*Purposely left blank.*

### 8-3 RECOMMENDATIONS FOR IMPROVEMENTS TO THE NTCIP STANDARDS

- **Revert decision to eliminate use of the 'NEMA node' mechanism** in conjunction with STMP.
- **Develop another object set for a separate time source**, i.e., WWW clock, to allow queuing of time and distribution of this time to all other devices (communications using NTCIP standard objects).
- **Develop standards for fiber-optic communications.**
- **Standardize the block objects** or, as a minimum, the approach to block objects.
- **Improve the NTCIP Exerciser.**
  - ⇒ Consider modifying the Exerciser to perform communications testing, and to help construct frames and setup frame sequences. <sup>39</sup>
  - ⇒ Improve the user interface and make the Exerciser more user-friendly.
- **Develop standard or universally accepted test procedures** to aid in compliance testing and in defining compliance.
- **Develop Compliance Levels** that allow a specifications writer to pick 'low level' conformance groups that represent specific functions.

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<sup>38</sup> The documents posted on the NTCIP web-site, and attendance at the NTCIP WG Meetings helped the AGENCY understand the NTCIP.

<sup>39</sup> Author's Note: the functionality to perform communications testing and to help construct frames is, and was always, included in the NTCIP Exerciser.

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## 8-4 THE NTCIP JOINT COMMITTEE AND FHWA

- **Publish and maintain a list of all Working Group work items** including descriptions in layman's terms".
- **Increase outreach and education** to inform customers.
- **Present a realistic picture of the NTCIP** in outreach programs; avoid presenting the NTCIP with a "marketing" spin.
- **Complete NTCIP Guide** as soon as possible. Include a general discussion of data exchange with respect to data rate, system status and upload/download. Specifically, discuss and define latency issues and bandwidth capabilities <sup>40</sup>.
- **Maintain the standards and provide funding** to support this maintenance effort. Integrate implementation findings into the standards as quickly as possible.
- **Develop realistic test-plans** or testing procedures to help compliance testing and conformance.

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<sup>40</sup> The new version of the NTCIP Guide is available on the NTCIP homepage and addresses these issues.

**ANNEX A: NTCIP EQUIPMENT DESCRIPTIONS**

**Table A1: Existing and New Equipment**

<b>Equipment information</b>	<b>Before project non-NTCIP</b>	<b>After project Non-NTCIP</b>	<b>After Project NTCIP</b>
Number of devices	810	N/A	860
Device Types	<u>SIGNAL CONTROLLERS:</u> NEMA TS1, Solid State Fixed Time controllers	<u>CCTV, VMS,</u> <u>RAMP METER</u> <u>CONTROLLER</u>	<u>SIGNAL CONTROLLERS:</u> Econolite ASC/2, PEEK M3000
Controller Connection	Multi-drop, UTCS mainframe based System  (and stand alone)	N/A	Multi-drop, Distributed PC-based System

**Table A2: NTCIP Conformance Groups Implemented for Signal Systems**

<b>Conformance Group</b>	<b>Reference Standard</b>	<b>Conformance Status</b>	<b>CAPABILITIES</b>	
			<b>Requested</b>	<b>Implemented</b>
Configuration	TS 3.4	Mandatory	Not specified	V=Y / SI=Y
Database Management	TS 3.4	Optional		V=Y
Time Management	TS 3.4	Optional		V=P / SI=Y
Timebase Event Schedule	TS 3.4	Optional		V=P
Report	TS 3.4	Optional		V=P
STMP	TS 3.4	Optional		V=Y
PMPP	TS 3.4	Optional		V=N
Phase	TS 3.5	Mandatory		V=Y / SI=partially
Detector	TS 3.5	Mandatory		V=Y / SI=partially
Vehicle Occupancy Report	TS 3.5	Optional		V=Y / SI=Y
Unit	TS 3.5	Optional	V=Y / SI=partially	

Annex A – Project-Specific NTCIP Items

Conformance Group	Reference Standard	Conformance Status	CAPABILITIES	
			Requested	Implemented
Special Function	TS 3.5	Optional		V=Y / SI=partially
Coordination	TS 3.5	Optional		V=P / SI=partially
Time Base	TS 3.5	Optional		V=P
Preempt	TS 3.5	Optional		V=P
Ring	TS 3.5	Optional		V=Y
Channel	TS 3.5	Optional		V=Y
Overlap	TS 3.5	Optional		V=Y / SI=partially
TS 2 Port 1	TS 3.5	Optional		V=Y

**Note 1:** V=Vendor, P = Private objects, SI=System Integrator, partial=a mix of mandatory and optional objects of a conformance groups were used, but not all mandatory objects were needed and therefore not supported.

**Note 2:** Portions of Coordination objects were supported (being able to command coordination were implemented using standard objects)

**Table A3: ECONOLITE ASC/2 Series Controller NTCIP Support**

In addition to the above description, the VENDOR provided the following information (*excerpt without any changes*) regarding the objects and the object ranges that are supported in this implementation. While providing this information deviates from the approach taken in other case studies, the authors felt this information was too important. However, the implementation also implemented a large number of proprietary objects, which are not provided due to intellectual property rights issues.



*Econolite is currently supporting NTCIP Class B communications in the ASC/2 Series controllers. The level of NTCIP support is as defined in the new NEMA TS2 specification recently approved by NEMA. The specification defines NTCIP Level 1 and Level 2 compliance for actuated controllers. A summary of the NEMA Level 1 and Level 2 compliance for actuated controllers, as set forth in the new TS2 standard, is included as an attachment to this document.*

*The ASC/2 controller can support system operation using the ASC/2 Level 1 NTCIP objects plus the ASC/2 private objects. Econolite NTCIP software for the ASC/2 controller is currently NEMA NTCIP Level 1 compliant (ASC/2 NTCIP software is currently undergoing integration testing for the Phoenix, AZ; Lakewood, CO; and Salt Lake City, UT ATMS projects). The ASC/2 Level 1 NTCIP software also supports the following optional conformance groups: Database Management as defined in TS 3.4, and Volume Occupancy Report, Unit, Special Function, Ring, Channel, Overlaps and TS2 Port 1 as defined in TS 3.5. Attached is a list of objects currently supported by the ASC/2 NTCIP Level 1 controller software.*

*The NTCIP optional Coordinator, Preemption and Timebase conformance groups are not supported with ASC/2 NTCIP Level 1 compliant software. However, all ASC/2 Coordinator, NIC, Time-of-Day, Holiday and Preemption functions are supported using private objects.*

Annex A – Project-Specific NTCIP Items

Although coordination is supported using private objects, three objects from the NTCIP Coordinator conformance group are supported: “coordPatternStatus”, “localFreeStatus” and “systemPatternControl”. See the *ASC/2 Programming Manual and Appendix B*.

Econolite can supply copies of the ASC/2 MIBs if required by project specifications.

The ASC/2 NEMA NTCIP Level 1 compliant software supports the Object Requirements as indicated in the table below.

**Table 1 –Object Requirements**

Object	Object Requirements
<b>TS 3.4</b>	
moduleType	Value 3
dbCreateTransaction	All Values
dbErrorType	All Values
globalDaylightSaving	Values 2 & 3
The timebase functions are implemented using private objects. The full ASC/2 NIC, Time-of-Day and Holiday programming operation is supported. Please see the <i>ASC/2 Programming Manual and Appendix B</i> . NEMA NTCIP timebase operation will be supported in the future release of ASC/2 NTCIP Level 2 compliant software.	
maxTimeBaseScheduleEntries	Future Level 2 (1999)
maxDayPlans	Future Level 2 (1999)
maxDayPlanEvents	Future Level 2 (1999)
maxEventLogConfigs	Future Level 2 (1999)
NEMA NTCIP event log recording will be supported with the future NTCIP Level 2 software. The ASC/2 now logs controller, detector and MMU. Our NTCIP Level 1 software will be capable of returning these logs using private objects.	
eventConfigMode	Future Level 2 (1999)
eventConfigAction	Future Level 2 (1999)
maxEventLogSize	Future Level 2 (1999)
maxEventClasses	Future Level 2 (1999)
maxGroupAddress	Future Level 2 (1999)
<b>TS 3.5</b>	
maxPhases	12
phaseStartup	Values 2 thru 6
phaseOptions	All Values
maxPhaseGroups	2
maxVehicleDetectors	64
vehicleDetectorOptions	All Values
maxPedestrianDetectors	12
unitAutoPedestrianClear	All Values
unitControlStatus	All Values
unitFlashStatus	All Values
unitControl	All Values
maxAlarmGroups	2

Annex A – Project-Specific NTCIP Items

Object	Object Requirements
<i>maxSpecialFunctionOutputs</i>	8
<p>The coordination functions are implemented using private objects. The full ASC/2 coordinator is supported. Please see the <u>ASC/2 Programming Manual</u> and Appendix B. NEMA NTCIP coordinator operation will be supported in the future release of ASC/2 NTCIP Level 2 compliant software.</p>	
<i>coordCorrectionMode</i>	Values 2 thru 4
<i>coordMaximumMode</i>	Values 2 thru 4
<i>coordForceMode</i>	Values 2 & 3
<i>maxPatterns</i>	64
<i>patternTableType</i>	2
<i>maxSplits</i>	12 (one per phase)
<i>splitMode</i>	Values 2 thru 7
<i>localFreeStatus</i>	Values 2 thru 6. The ASC/2 coordinator takes other corrective action to handle bad cycle lengths and out-of-range offsets.
<p>The timebase functions are implemented using private objects. The full ASC/2 NIC, Time-of-Day and Holiday programming operation is supported. Please see the <u>ASC/2 Programming Manual</u> and Appendix B. NEMA NTCIP timebase operation will be supported in the future release of ASC/2 NTCIP Level 2 compliant software.</p>	
<i>maxTimebaseASCActions</i>	The ASC/2 supports timebase operation using private objects, which offer 200 NIC steps and 100 time-of-day steps. Appendix B lists all private timebase related objects. Please refer also to the <u>ASC/2 Programming Manual</u> , 8
<p>The preemption functions are implemented using private objects. The full ASC/2 preemptor, including priority and bus preemption, is supported. Please see the <u>ASC/2 Programming Manual</u> and Appendix B. NEMA NTCIP preemptor operation will be supported in the future release of ASC/2 NTCIP Level 2 compliant software.</p>	
<i>maxPreempts</i>	6 plus 4 bus_
<i>preemptControl</i>	Private objects.
<i>preemptState</i>	Private objects.
<i>maxRings</i>	2
<i>maxSequences</i>	The ASC/2 uses the Alternate Sequence operation as defined in the NEMA TS2 specification that essentially supports 16 sequence plans. NEMA NTCIP sequence control will be supported in the future release of ASC/2 NTCIP Level 2 compliant software.
<i>maxChannels</i>	16
<i>channelControlType</i>	Values 2 thru 4
<i>channelFlash</i>	Values 0, 2, 4, 6, 8, 10, 12, & 14
<i>channelDim</i>	Values 0 thru 15
<i>maxChannelStatusGroups</i>	2
<i>maxOverlaps</i>	4
<i>overlapType</i>	Values 2 & 3
<i>maxOverlapStatusGroups</i>	1

Annex A – Project-Specific NTCIP Items

Object	Object Requirements
maxPort1Addresses	18
port1Status	Values 2 & 3

**Enhancements**

1. *Extended detector alarm capability provides for up to three different detector alarm periods each day for each of 64 detectors. The NTCIP specification requires only one alarm period.*
2. *Extended objects support the complete set of ASC/2 Phase, Detector and Overlap functions. Please see Appendix B for a listing of all supported objects.*
3. *Because upload and download operations are very slow using 1200 bps data rates, Econolite supports block upload and download of the ASC/2 database using private MIBs.*

**Table A4: Supported Communications Object Definitions**

Conformance Group	Reference Standard	Conformance Status	CAPABILITIES	
			Requested	Implemented
RFC 1213-MIB – data elements	TS 3.3	Mandatory	Not specified	V=Y / SI=N
atTable data elements				V=N / SI=N
netToMediaTable-data elements				V=N / SI=N
RFC 1317-MIB – data elements	TS 3.3	Mandatory		V=Y / SI=N
RFC 1381-MIB –data elements	TS 3.3	Mandatory		V=Y / SI=N
Support of Traps?	TS 3.3	Optional		V=N / SI=N
STMP	TS 3.4	Optional		V=Y / SI=Y
PMPP	TS 3.4	Optional		V=N / SI=N

**Table A5: Supported Communications Equipment and Communications Speeds**

TECHNOLOGY	1200 bps	2400 bps	9600 bps	14.4 Kbps	19.2 Kbps	56 Kbps	COMMENTS
Multi-drop, half duplex	V						
Multi-drop, full duplex			V				
Dial-up - Wire-line							

Annex A – Project-Specific NTCIP Items

<i>TECHNOLOGY</i>	<i>1200 bps</i>	<i>2400 bps</i>	<i>9600 bps</i>	<i>14.4 Kbps</i>	<i>19.2 Kbps</i>	<i>56 Kbps</i>	<i>COMMENTS</i>
Dial-up - Wire-less							

VENDOR: only Class B Profile was implemented.

**ANNEX B: PRE-QUALIFICATION – TRAFFIC SIGNAL CONTROLLER****REQUEST FOR PROPOSAL****City of Phoenix****Prequalification for****Traffic Signal Controller Assemblies****INTRODUCTION**

The City of Phoenix, Arizona, as a part of an ongoing upgrade of the City's Traffic Signal System, is seeking proposals from qualified suppliers of traffic signal controller equipment.

The City is transitioning from the existing Modcomp/Computran computerized system to a new distributed control system which will provide local intersection control through timing plans resident at the intersection controller and selected primarily from time of day schedules.

Of the approximately 800 signalized intersections, all traffic signal controllers and approximately 350 cabinets will be replaced in a staged effort over multiple years, or purchases. It is the intent of this effort to provide new NEMA TS 2 machines capable of Type 1 and Type 2 actuated configurations from a single controller unit.

**SCOPE OF WORK**

The purpose of this solicitation for proposals is to identify, evaluate and prequalify traffic signal controller assemblies per this specification. Elements of the controller assemblies must consider and be compatible with the architecture of the new City traffic signal system to the extent that new controllers are compatible with the desired control strategies, features and communications protocol.

Additional information about the City's new traffic signal system, beyond that contained herein, may be obtained by contacting Mr. John Prowse (602-262-4692) or Mr. Joel Havris (602-262-4691), City of Phoenix (FAX: 602-495-0345).

Purchase of traffic signal controllers, Malfunction Management Units, cabinets and other peripheral equipment shall be through subsequent Invitation For Bids (IFB).

This solicitation is for fully functional controller assemblies complying with the NEMA TS 2 specification which have demonstrated field experience prior to this solicitation. Prototypes or controllers which "will be available soon" are not acceptable. This prequalification process is open continuously as new assemblies become available from various manufacturers.

Proposers shall supply the City with one complete controller assembly configured for testing with the new traffic signal system. The City shall use the NTCIP protocol.

Proposers with an incomplete submittal will be given ten (10) working days after date of notification to complete submittal. After ten days, if submittal is still incomplete, it will be deemed not in compliance and be sent back to the manufacturer.

Proposers with a submittal found not to meet specifications will be deemed not in compliance and be sent back to the manufacturer.

Proposers found not in compliance may resubmit not less than thirty (30) days after notification of non-compliance.

**PROPOSAL FORMAT**

Proposals shall contain the following:

1. Background of the manufacturer, including a brief company history indicating location of manufacturing plant, other names the company has utilized in the past, companies that have merged or affiliated with manufacturer and how long the proposed equipment has been manufactured. Indicate sales staff structure (direct, local rep., etc.), technical support structure and designated liaison for the City of Phoenix, product support (warranty) policy and training capabilities for technical and engineering staff of the City.
2. Proposal of equipment intended to provide, including all features necessary to comply with the compatibility to the new traffic signal system and to the NEMA TS 2 specification. Indicate at least three reference names, agency and telephone numbers of public sector users of the specific units proposed for this prequalification. If this requirement cannot be strictly met, provide the reason.
3. List of spare parts and suggested diagnostic/repair equipment that can be supplied to the City. Information shall be of adequate detail for the City to reasonably interpret the product and intended use. Provide description of training that can be provided to City staff. Training options shall include 16 hours for technical and engineering staff. The City shall provide the training room and proposer shall provide training materials. Training shall be provided in person, to a group of City staff, by competent factory representatives knowledgeable in technical, operational, architectural and communications issues.
4. Indicate compliance with the NEMA TS 2 specification by providing a certificate of compliance from an independent laboratory. Indicate any special controller features or capabilities beyond those required for this prequalification. If the proposer anticipates modifications to accommodate future implementations (update of communication protocol, for example), the process to be followed shall be clearly conveyed. Clearly indicate any information required from the City for this purpose.
5. Provide any other pertinent support documentation or other information necessary for the City to fully evaluate the submittal.

**PREQUALIFICATION CRITERIA**

Proposals will be received by the City and evaluated. Upon verification of these criteria, the proposer's products will be placed on a Qualified Products List (QPL) for future Invitations for Bid (IFB).

Proposers shall supply and deliver one complete controller assembly for evaluation. Proposer shall be responsible for all costs of shipping to and from the City's test facility, and shall be available for responding to questions and other reasonable requests of the City during evaluation. Test units shall be sent to:

Mr. Don Hoffman  
 Traffic Signal Superintendent  
 City of Phoenix  
 Street Transportation Department  
 2631 S. 22nd Avenue  
 Phoenix, Arizona 85009  
 (602) 262-6056

Evaluation criteria shall include, but not be limited to:

- **PROVEN FIELD EXPERIENCE**  
 Product performance and reliability based on demonstrated field experience.
- **SPECIFICATION COMPLIANCE**

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**Annex B – RFP for Traffic Signal Controller**

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Product compatibility with the new traffic signal system and compliance with NEMA TS 2 and these specifications.

▪ **PRODUCT SUPPORT**

Product support policy as it applies to the process for replacement/repair of components.

▪ **COMMUNICATIONS PROTOCOL COMPATIBILITY**

***Product compatibility and plan for any future upgrades as proposed by the supplier to meet the communications standards and needs of the City's new traffic signal system.***

## **SPECIFICATIONS**

1. Controller assemblies shall comply with the National Electrical Manufacturers Association Standards Publication No. TS 2, Traffic Controller Assemblies document and additional provisions herein.
2. Controller units shall provide Type 1 and Type 2 configurations in a single unit. The Type 2 features will be tested in a City-supplied NEMA TS 1 cabinet for downward compatibility.
3. Proposer shall provide a manufacturer standard TS 2 Type 1 cabinet as a part of the controller assembly. The cabinet shall meet TS 2 configuration 3 or 4 (Table 5.3.1-1, p. 99 of NEMA TS 2 specification) and be supplied with all BIU's, Loop Detectors, Malfunction Management Unit, power supply and load switches to fill all sockets.
4. Units must be fully operational and have demonstrated field experience at the time of submittal. Units under development or otherwise incomplete or not fully in compliance with these specifications are not acceptable.
5. Controller assembly shall be capable of interface and operation with the City's new traffic signal system, including allowing upload and download of data, operation from time of day schedules in selecting timing plans, providing feedback to the central office for observation, and accumulation and transmission of detector data on request.
6. Controller shall be capable of reading all Malfunction Management Unit parameters and condition alarms/log into its memory for uploading on request from the central office.
7. Controller assembly shall be provided with software and connecting cable for transferring timing parameters between a notebook computer and the controller unit. Proposer shall verify compatibility with the City's existing notebook computers and provide a configuration that will operate properly.
8. Controller units shall be capable of an operational communications protocol allowing full communications to the City's new traffic signal system. Protocol is based on the latest version of the NTCIP protocol. If NTCIP is updated/revised in the future, the City will desire such updates to be implemented in controllers.
9. Controller assembly components which utilize keyboards shall utilize mechanical push button type keypads. Membrane keypad surfaces are not acceptable.
10. Default timing parameters shall be provided in all controllers.
11. All timing and operational parameters shall be internally stored in the controller unit by means of a non-volatile memory that is capable of storage for up to 1,000 hours without data loss.
12. Controller shall allow modification of the ring structure via user programmable entry. Default structure shall be Dual-Ring, 8-Phase NEMA configuration with leading left turns (odd-numbered phases).

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**Annex B – RFP for Traffic Signal Controller**

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13. Controller shall be able to accumulate and store detector data and make such data available for upload to the central office upon request from the central office. Storage shall be capable of accumulating a minimum of 72 hours of data for a minimum of 12 user-selectable detector inputs.
14. Controller shall be capable of providing data bit feedback to the central office to indicate:
  - Door Open
  - Laptop Connected
  - Front Panel Accessed
15. Under internal coordination, the controller shall have the capability to "Rest In Walk" on any single and/or multiple phases (Example: Phases 2, 4, 6 & 8) within the same cycle.
16. Unused left turn phase time shall be assigned to the complimentary through phase.
17. The controller shall have the ability to logically gate detector inputs to place calls on selected phases. One application would be the use of "3rd car" detection for left turn phases whereby both front and rear loops in a turn lane must be occupied simultaneously before a call is placed on the phase.
18. Proposers shall provide the City with all information identifying manufacturer-specific features and functions contained within the proposed NTCIP protocol beyond those specified and required by the NTCIP definition.
19. Controller unit shall be capable of half and full duplex communications over voice grade telephone lines via the internal modem. Controllers shall be delivered configured for half duplex, or be capable of software selection of duplex mode via the keyboard.
20. Controller unit shall be capable of placing vehicle and pedestrian calls via the keyboard to all phases.
21. Controller unit shall be capable of setting each detector channel to lock or non-lock operation independently of phase assignments.
22. Controller unit shall be capable of distinguishing between the high and low priority preempt signal from the Opticom™ preemption system.

**ANNEX C: INVITATION FOR BID - TRAFFIC SIGNAL CONTROLLER****CITY OF PHOENIX****IFB NO. Xxx****TRAFFIC SIGNAL CONTROLLER**

The City of Phoenix invites sealed bids for traffic signal controller, in accordance with the provisions, specifications, and bidding instructions set forth in this Invitation for Bid. Bids will be received by the Materials Management Division, Fourth Floor, 251 W. Washington, Phoenix, Arizona 85003, until 10:30 a.m., local time, xxxxxxxxxx, at which time they will be opened and publicly read. Late bids will not be considered.

In order for your bid or quotation to be considered, your firm must comply with Phoenix City Code, 1969, Chapter 18, Article V, as amended, Affirmative Action Program. Failure to comply with the reporting requirements of this ordinance will result in your bid being rejected. Firms are also responsible for maintaining their eligibility during the life of any contract and failure to do so may result in termination of the contract. A form has been included within this IFB package to assist you in complying with the ordinance. Any questions in regard to this Affirmative Action Program should be directed to the Affirmative Action Contractor Compliance Section of the Equal Opportunity Department, (602) 262-6790. The City of Phoenix extends to each individual, firm, vendor, supplier, contractor and subcontractor an equal economic opportunity to compete for City business. Successful majority firms are expected to use disadvantaged, minority-owned and women-owned businesses in the subcontracting and purchasing of services and commodities that reflect the business community ethnic composition.

Any questions in regard to this bid should be directed to Dick Giorza, Senior MRO Buyer, (602) 262-4439, Materials Management Division.

A printed copy of the bid tabulation will be available upon written request to the Materials Management Division. Telephone requests will not be accepted. Each written request must contain a self-addressed, stamped envelope and must reference the bid title and number. Bid tabulations will be posted and available for public viewing in the reception room of the Materials Management Division for a period of 60 days from the bid opening date.

**1. ADDITIONAL CONDITIONS OF PURCHASE****1.1 FOB POINT**

Prices quoted shall be FOB Street Transportation, Signal Shop, 2631 South 22nd Avenue, Phoenix, AZ 85009, and unloaded.

## 1.2 METHOD OF ORDERING

Issuance of written purchase order(s) by the Materials Management Division. Contractor shall deliver items and/or services only upon receipt of a written purchase order issued by the Materials Management Division. All contractor invoices and packing/delivery tickets must include the City of Phoenix purchase order number.

## 1.3 METHOD OF PAYMENT

Payment to be made from Vendor's invoice, and a copy of the signed delivery invoices, submitted to cover items received and accepted during the billing period. Invoices must contain the agreement number or bid number under which the contract is awarded.

## 1.4 QUALIFIED PRODUCTS LIST

Bidders shall submit bids only for those products listed on the City of Phoenix Qualified Products List (QPL). Bid submitted for products which have not been tested and qualified by the City of Phoenix will be considered as non-responsive and rejected.

Suppliers that have products which may qualify should contact the Traffic Signal Division for possible inclusion on the City's QPL for future bids.

IN NO EVENT WILL BIDS FOR PRODUCTS NOT LISTED ON THE CITY'S QPL AS OF THE DATE THIS IFB WAS PUBLICLY ADVERTISED, BE CONSIDERED.

## 1.5 GUARANTEE AND WARRANTY

**GUARANTEE:** All items provided as a result of this bid shall be guaranteed by the seller as to compliance with the bid specifications.

**WARRANTY:** All signal equipment covered under this specification shall be warranted against any and all defects of design, workmanship and material or mechanical and

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**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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electrical defects for a period of twenty-four (24) months from date of installation or thirty-two (32) months from the date of delivery, whichever is less.

Fully corrected repairs or replacement of defective equipment made by the seller shall be to the satisfaction of the City, without cost to the City. Two-way shipping costs for such equipment, between the City and the designated seller's facility, shall be borne by seller.

**1.6 OPTION**

By signing and submitting this bid, Bidder agrees that the City may, at any time prior to one year, purchase additional quantities up to and including 100 percent of the quantities specified at these bid prices and conforming to bid specifications.

**1.7 PRICE PREFERENCE FOR PRODUCTS/SERVICES OFFERED BY A MINORITY OWNED BUSINESS ENTERPRISE (MBE) OR WOMAN OWNED BUSINESS ENTERPRISE (WBE)**

In accordance with Ordinance G-3707, a 5% price preference will be given to local MBE or WBE firms. In determining the lowest responsive and responsible bid or proposal, any bid or proposal submitted by a local certified MBE or WBE firm shall be adjusted by reducing the price(s) of such bidder or proposer by 5%. This adjustment shall be solely for the purpose of establishing the apparent low bidder or proposer. The actual value of any contract awarded shall be the amount of the actual bid or proposal submitted by the MBE or WBE. To be eligible for the price preference, MBE or WBE firms must be certified as such by the City's Equal Opportunity Department, under the conditions set forth in Ordinance G-3695. **THIS CLAUSE IS NOT APPLICABLE FOR SOLICITATIONS INVOLVING CONTRACTS WITH AN ANNUAL VALUE THAT WILL EXCEED \$500,000.**

**1.8 PRICE PREFERENCE FOR JOINT VENTURES INVOLVING MBE OR WBE FIRMS**

In accordance with Ordinance G-3707, any qualified joint venture shall receive a five percent (5%) price preference when local MBE or local WBE participation equals or exceeds thirty-five percent (35%) of the Joint Venture (JV). The MBE or WBE Joint Venture partner must be responsible for a clearly defined portion of the work to be performed. This portion must be set forth in detail separately from the work to be performed by the non-MBE or non-WBE JV partner.

The MBE/WBE JV partner's work must be assigned a commercially reasonable dollar value and use its own employees and equipment. The MBE/ WBE JV partner must share in the ownership, control, management and administrative responsibilities, risks, and profit of the JV, in direct proportion to its stated level of JV participation. The MBE/ WBE JV partner must perform work that is commensurate with its experience. The MBE/ WBE JV partner must be a certified local vendor by the City's Equal Opportunity Department.

To be considered, the bidder or proposer must so state in writing with their bid or proposal response, their intention to perform the contract under a Joint Venture arrangement

**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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with a MBE or WBE firm and must have applied for Joint Venture Certification by the City's Equal Opportunity Department, **PRIOR TO THE BID OPENING DATE AND TIME**. The price preference will not be applied to bids or proposals submitted on a joint-venture basis, if the application for certification was not received by the Equal Opportunity Department prior to the bid opening date and time. Contact Carolyn Gall, Equal Opportunity Specialist, (602) 261-8899 ; FAX (602) 534-1124, to apply for certification as an MBE/WBE Joint Venture.

THIS CLAUSE IS NOT APPLICABLE FOR SOLICITATIONS INVOLVING CONTRACTS WITH AN ANNUAL VALUE THAT WILL EXCEED \$500,000.

**2. SCOPE**

For the supply of the following traffic signal equipment.

<u>ITEM</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
1.	120 Each	Controller units

A. CONTROLLERS

In accordance with the City of Phoenix Qualified Products List (Q.P.L.).

B. QUALIFIED PRODUCTS

Xxxxxx

These products must be the same version that was evaluated and prequalified by the City of Phoenix.

C. Each controller unit shall be supplied with a port 3 cable 6' in length.

<u>ITEM</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
2.	40 Each	Controllers and cabinets(size 6)

A. CONTROLLERS with CABINETS- (size 6)

**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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In accordance with the City of Phoenix Qualified Products List (Q.P.L.) and cabinet as described in attached City of Phoenix Specifications No. 1.

**B. QUALIFIED PRODUCTS**

Xxxxxxxx

These products must be the same version that was evaluated and prequalified by the City of Phoenix.

C. Each cabinet shall be configured as type 1, configuration 4, per table 5.3.1-1 the NEMA standards publication TS-2.

D. Each cabinet shall be supplied with six (6), NEMA TS-2 TYPE A detectors.

E. Twelve (12) load switches shall be supplied with each cabinet.

<u>ITEM</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
3.	40 Each	Controllers and cabinets(size 4)

**A. CONTROLLERS with CABINETS- (size 4)**

In accordance with the City of Phoenix Qualified Products List (Q.P.L.) and cabinet as described in attached City of Phoenix Specifications No. 1.

**B. QUALIFIED PRODUCTS**

Xxxxxxxx

These products must be the same version that was evaluated and prequalified by the City of Phoenix.

**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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C. Each cabinet shall be configured as type 1, configuration 1, per table 5.3.1-1t he NEMA standards publication TS-2.

D. Each cabinet shall be supplied with three (3), NEMA TS-2 TYPE A detectors.

E. Four (4) load switches shall be supplied with each cabinet.

ITEM            QUANTITY    DESCRIPTION

4. This bid shall include all of the following:

A. Five (5) A.C. power cables with appropriate connectors for bench operation of the controllers without the cabinet. These cables shall be a minimum of six feet (6') in length.

B. Six (6) complete sets of extender boards to permit bench testing and troubleshooting of all controller components parts and power supplies.

C. Thirty-five (35) complete sets of manuals shall be supplied with this bid item. These manuals shall include information on detectors, monitor, controller, load switches, flashers, etc.

The instruction manual shall incorporate, as a minimum, the following information:

- a. Table of contents.
- b. Complete operating procedure.
- c. Theory of operation.
- d. Maintenance and troubleshooting guides.
- e. Step-by-step procedures for all assemblies capable of being adjusted.
- f. Component parts location diagrams.
- g. Schematic diagrams.
- h. Operational block diagrams.
- i. Parts lists.

All printed material shall be legible high quality copies.

D. Eight (8) notebook microcomputers as described below shall be provided as part of this bid item. Each notebook shall be supplied with all necessary cables and connectors to

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**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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perform data transfer to and from controllers provided. Each notebook shall be supplied with all necessary interface software.

Specifically, the following parameters should be considered as minimum standards for any references to notebook microcomputers:

I. The notebook computer shall be provided with software, cables and equipment to accept all upload/download information from the supplied traffic signal controller, transfer all controller program information to controller, and store intersection data.

II. The notebook computer processor shall be a minimum 75mhz Pentium.

III. The memory requirements for the notebook are a minimum of 8MB of RAM expandable to 40MB.

IV. The screen of the notebook computer shall be at least 10.4" black matrix TFT color display with 65,536 colors visible at 800x600.

V. This unit shall have as a minimum an internal 540MB hard disk, a PCMCIA card slot (supplied with 10MB PCMCIA card with compression software), and an internal 3.5" 1.44MB floppy drive.

VI. The notebook shall have an on board track point, a serial port, a parallel port.

VII. The notebook shall be battery powered with rechargeable batteries and AC adapter supplied.

VIII. The notebook will be supplied with a case capable of carrying the notebook, ac adapter, and controller patch cable.

IX. Units known to meet these requirements are manufactured by IBM, specifically the THINKPAD 755 CX.

E. One (1) NEMA TS-2 MMU tester. The tester shall be supplied with all necessary cables, connectors, software and instruction manuals for testing.

I. The tester shall be capable of testing the NEMA TS-2 type 1 MMU.

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**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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- II. The tester shall be portable for field or shop use.
  
- III. A unit known to meet these standards are manufactured by Athens Technical Specialists, INC. The current model being PCMT-2000.
  
- F. One (1) NEMA TS-2 type 1 traffic signal controller tester (suitcase tester) as described below shall be provided as part of this bid. The tester shall be supplied with all the necessary cables, connector and instruction manuals for testing the controller provided under this item.
  - I. The tester shall test all standard and extended NEMA controller functions.
  - II. The tester shall have an internal 24 vdc power supply.
  - III. The test unit shall be portable for field or shop use.
  
- G. Eight (8) additional NEMA TS-2 type 1 power supply units as supplied with the cabinets of this bid.
  
- H. Eight (8) additional NEMA TS-2 type 1 MMU units as supplied with the cabinets of this bid.
  
- I. Eight (8) additional NEMA TS-2 type 1 BIU units as supplied with the cabinets of this bid.
  
- J. The successful bidder shall supply Video Cassette Training Tapes as part of this bid. The video tapes shall contain, but not be limited to the following requirements:
  - I. VHS Format, one-half inch tape.
  - II. Standard Speed T-120.
  - III. Approximately two (2) hours of operator front panel instruction.

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**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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IV. Approximately eight (8) hours of technical maintenance and troubleshooting instruction.

V. The tapes shall be indexed by footage to identify course elements.

VI. The tapes shall be the property of the City of Phoenix.

VII. The tapes shall be capable of being reproduced.

VIII. The tapes shall be delivered to:

Don Hoffman, Traffic Signals Superintendent  
Street Transportation Department  
2531 South 22nd Avenue  
Phoenix, AZ 85009  
(602) 262-6065

IX. The tapes shall be delivered on or before the day of shipping the controllers.

X. Tape presentations shall be made by factory-trained personnel.

XI. The instructional manuals as required in Paragraph C above shall be used in conjunction with the training program.

XII. Successful bidder shall contact Mr. Don Hoffman, (602) 262-6056, for coordination and training format.

K. In lieu of the described Video Cassette Training Tapes, the successful bidder may provide two (2), two-day training sessions, given by a qualified technical representative of the bidder's firm. The training sessions shall include, but not be limited to all requirements of the Video Tapes. The sessions shall be conducted at the City's Electrical Facilities Building. The sessions shall be video taped by the City of Phoenix. The resulting tapes shall be the sole property of the City and for the sole use of the City.

L. The format and scheduling of these sessions shall be coordinated with Don Hoffman. Mr. Hoffman shall be contacted by the successful bidder approximately one (1) week prior to delivery of control equipment for the purpose of discussing the format and scheduling of

**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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sessions. The sessions shall be conducted within thirty (30) days of delivery of control equipment.

M. The successful bidder shall provide all necessary training materials and equipment for the Training Sessions.

N. The successful bidder shall provide a software update(s) for the controller units based on an agreed upon or final revision of the NTCIP protocol . In addition the successful bidder shall provide the city with all information identifying manufacturer specific features and functions beyond those specified and and required by the NTCIP definition.

**2.1 SPECIFICATIONS NO. 1****A. CABINETS, WIRING AND ACCESSORY EQUIPMENT**

1. The successful bidder shall be responsible for the proper installation of all wiring in cabinets, and all equipment as described in National Electrical Manufacturers Association (NEMA) Standards Publication No . TS-2 type 1, current edition, and these specifications.

2. Cabinets must be aluminum and of sufficient rigidity and quality to withstand citizen abuse and not flex on its mount.

3. Cabinets shall be supplied with the proper mounting hardware. Size 4 cabinets (2-phase) shall be provided with "Band-It" type pole mounting hardware of adequate size and strength for rigid mounting to a City of Phoenix standard pole. Size 6 cabinets (8-phase) shall be supplied with the appropriate dimensional diagrams for concrete pad mounting, and conform to Figure 7.8.3-2 (Sizes 6 and 7) of NEMA TS 2.

4. Size 6 cabinets shall be supplied with a means of attaching a chain or rope to two (2) ears with one-inch (1" ) inside diameter holes, at the top of the cabinet for the purpose of lifting and mounting the cabinet. The two (2) ears shall be removable after the cabinet has been installed, so as not to detract from the cabinet's appearance. A means of resealing the cabinet from weather after the ears have been removed shall be supplied with the cabinet.

5. No cabinet main door or police compartment door keys shall be provided.

6. Cabinets shall be supplied with door handle assemblies and hinges which will provide smooth, reliable operation for the life of the cabinet. The door handle assembly shall have a stainless steel shaft of no less than 1 /2 inch diameter. The door hinges shall be continuous hinges with stainless steel hinge pins.

7. Cabinets shall be supplied with the exterior painted white. The cabinet surface shall be properly prepared for painting and a primer paint coat applied. The interior surfaces shall remain unpainted.

8. Cabinets shall be supplied with a metal file box attached to the inside of the cabinet door. The file box shall be of adequate size to house standard 8-1/2 inch by 11 inch documents without folding, and provide a top opening protected by a continuous hinged flap or door. All box edges shall be filed smooth. The box thickness shall be a minimum of two (2) inches.

## **B. SOLID STATE LOAD SWITCHES**

All Solid State Load Switches shall conform to the Standards of NEMA TS 2, Section 6, with the following exception:

Each switching circuit shall have a minimum rating of 15 amperes for either a tungsten lamp load or power factor corrected gas tubing transformer load over a voltage range of 89 to 135 volts RMS AC at 60 Hertz.

## **C. TERMINALS AND FACILITIES**

All terminals and facilities shall conform to the standards of NEMA TS 2, with the following exceptions:

### **1. GENERAL**

Table 5.3.6-1 Signal Feeds shall be barrier block, 15 amperes minimum. No compression type terminals will be acceptable.

### **2. GROUNDING SYSTEM**

All grounding system buses shall be a solid copper multi-terminal strip.

### **3. DISCONNECTING MEANS**

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**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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- a. Ceramic fuse holders similar to BUSS No. 2601 and 2602 shall be used in place of circuit breakers.
- b. Size 4 cabinets (2-phase) shall be fused by a NON 30A cartridge fuse for Main Power.
- c. Size 6 cabinets (8-phase) shall be fused by a NON 35A cartridge fuse for Main Power.
- d. All cabinets shall be fused by a NON 20A cartridge fuse for Auxiliary Power.

**4. SIGNAL BUS**

The current rating of the signal bus mercury contactor shall be 60 amperes.

**5. AUXILIARY DEVICES**

- a. One (1) duplex, three-prong, 15 ampere ground fault interrupter (GFI) convenience outlet shall be supplied and wired in accordance with National Electrical Code (NEC) Standards.
- b. Cabinet Light:
  1. A fluorescent fixture and light shall be mounted in the cabinet in a position to illuminate the front of the controller. The light fixture or tube shall not interfere with placement or removal of control equipment.
  2. The standard fluorescent fixture shall be of a length that a given cabinet will permit.
  3. The ballast shall be of the rapid start variety. (Starters are unacceptable).
  4. The cabinet light shall be switched by means of a manual toggle switch, and shall be properly labeled. A door operated switch is not acceptable.

- c. Cabinet Fan:

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**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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1. A top-mounted, weatherproof, thermostatically-controlled fan shall be installed and wired.
2. The fan shall be performance rated at 100,000 hours continuous.
3. The fan shall be capable of 120 cubic feet per minute (CFM), minimum.
4. The thermostat shall have a spike suppressor across its contacts.
5. The fan's characteristics and physical dimensions shall be Pamotor Pentaflow Model No. 4600XP, 1-1/2 x 4-1/2 x 1-1/2, or equal.

**6. WIRE**

All wire used in controller cabinets shall be stranded copper, regardless of size.

**7. FLASH TRANSFER CONTROL**

The contact points and contact arms shall be capable of operating for 30,000 cycles with 15 amperes of tungsten load per contact at 120 VAC.

**8. MALFUNCTION MANAGEMENT UNIT**

- a. All malfunction management units provided must be supplied with certification that they comply fully to the requirements of the NEMA TS 2 specification.
- b. Each cabinet shall be supplied with a functionally wired 16 channel signal malfunction management unit.
- c. The malfunction management unit shall be wired to put the intersection on flash if a malfunction is detected and also wired to apply stop time to the controller.
- d. All malfunction management units shall be functionally wired to utilize their maximum capability, i.e., absence of red, +24 VDC, voltage monitor, etc.

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**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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e. The malfunction management unit wire shall be attached to all connections in such a manner which allows removal of each individual wire with a screwdriver, without removing other components.

## **D. ADDITIONAL REQUIREMENTS**

In addition to the standards of NEMA TS 2 and the exceptions described above, each cabinet shall include the following:

### **1. CONTROL SWITCHES**

All switches shall be supplied and functionally wired. Each switch shall be identified.

Definitions:

- a. Control Power AC power to energize control and auxiliary equipment.
- b. Signal Power AC power applied to traffic signal light control units.

### **2. POLICE PANEL SWITCHES**

#### a. Auto-Flash Switch

- 1. Auto Position Control Power and Signal Power on. Normal operation.
- 2. Flash Position Control Power on, Signal Power off. Signals flashing.

#### b. Field Signal Power

- 1. On Position Control Power and Signal Power on. Normal operation.
- 2. Off Position Control Power on, Signal Power off. All field signal indications shall be off.

#### c. Auto-Manual

1. Auto Position Control Power and Signal Power on. Normal operation.

2. Manual Position Control Power and Signal Power on. In this position the controller shall be placed in a safe manual control operation, enabling signal indication changes with the Remote Manual control switch described below.

d. Remote Manual Control (Hand Switch)

A functionally-wired, environmentally sealed momentary push button hand switch shall be supplied with a cord that will extend six (6) feet. Provision shall be made for neat cord and hand switch storage within the police panel. This hand switch cord shall be permanently wired and shall not be plugged-in removable.

### **3. INTERIOR CABINET SWITCHES**

a. Main Switch

1. On Position Control Power and Signal Power on. Normal operation.

2. Off Position Control Power and Signal Power off. Signals off.

b. Auto-Flash Switch

1. Auto Position Control Power and Signal Power on. Normal operation.

2. Flash Position Control Power off, Signal Power off, malfunction management unit power off. Signals flashing.

c. Field Signal Power

1. On Position Control Power and Signal Power on. Normal operation.

2. Off Position Control Power on, Signal Power off. All field signal indications shall be off.

- d. There shall not be a stop time switch installed on the interior door panel.

#### **4. CABINET LOAD CENTER PANEL**

- a. All components such as filters and relays shall be wired and mounted for easy access and removal without removal of panels. (No component shall be mounted or installed behind any panel).
  
- b. The panel(s) shall be mounted in the cabinet in such a manner that it/they may be easily removed with the use of simple tools for access to the various sockets and wiring. All interior wiring to a panel shall be of a length that will permit placing the panel in a horizontal position at the bottom of the cabinet without causing strain on the wires and connections.

#### **5. WIRING AND TERMINALS**

- a. All cabinet wiring shall be neat and firm and all harness and cabinet wiring shall be laced, sleeved or bound together with cable ties. All wiring connectors within the cabinet shall be strain relieved with friction clamps. No potting compound, soft or hard, will be used in any connector.
  
- b. All wiring between the main panel and all sub-panels, terminal strips, bus bars and fuse blocks shall have sufficient slack to permit backside access without loosening or removing cable clamps, cable ties or any other harness supporting device.
  
- c. All interconnections on the back panel and side panels shall be either screw terminals or soldered connections. No friction fit connections will be accepted. All screw terminals shall be accessible without removing panels or the backboard.
  
- d. Two (2) complete sets of cabinet prints for each cabinet shall be supplied. These prints shall identify all of the wiring to cabinet connectors, terminal blocks and accessory equipment, and shall include the latest revisions, including any special City of Phoenix wiring revisions included in these specifications. Prints shall be delivered properly folded and stored in the door storage box.
  
- e. Each cabinet shall be provided with radio interference suppression devices (RFI). The RFI filter for Size 4 cabinets (2-phase) cabinets shall have a minimum rating of 50 amperes. For Size 6 cabinets (8-phase), the minimum rating shall be 60 amperes.

- f. Each cabinet shall be provided with a port 3 cable terminated on a terminal strip

#### **E. GUARANTEE**

1. All accessory equipment and fully-wired cabinets shall be guaranteed by the manufacturer against mechanical and electrical defects for a period of twenty-four (24) months from the date of installation, or thirty-two (32) months from the date of delivery, whichever is less.
2. Any defects of design, workmanship, or material shall be fully corrected by the manufacturer without cost to the City. The bidder shall pay all shipping charges for equipment returned for repair under warranty.
3. The equipment shall be warranted to meet all requirements of this specification at the time of installation.

#### **F. WORKMANSHIP**

1. The accessory equipment furnished under this specification shall be the most improved model, past the development stage, and in factory production.
2. The equipment shall conform to current high standards of production, levels of workmanship, and materials used, as has become the experience of the City of Phoenix.

#### **G. DATA**

The successful bidder must provide manufacturer's technical specifications, graphs, photographs, circuit diagrams, instruction manuals, or other means to fully describe all accessory equipment, including fan, light fixture, mercury contactor, switches, RFI filter, flash transfer relay, transient suppression devices, cabinet hardware, and all other components used in the cabinets.

#### **H. DEVELOPMENT DATA**

The successful bidder shall agree to supply free of charge all data, drawings, and specifications which may be the result of future development, by which performance and efficiency of equipment purchased under this specification may be improved or modernized.

**CITY OF PHOENIX**

**Phoenix, Arizona**

**INVITATION FOR BID - IFB NO. Xxx**  
**SUBJECT MATTER - TRAFFIC SIGNAL CONTROLLER**  
**OPENING DATE AND TIME - xxxxxxxx**

BIDDER'S OFFER

**3. SUBMITTALS**

In order to be considered, bidder must complete and submit their bid on this form to the City of Phoenix Materials Management Division at the Fourth Floor, 251 West Washington, Phoenix, Arizona 85003, by no later than the opening date and time cited above. Please identify as a sealed bid in accordance with the instructions of Provision 2 of General Bidding Instructions and Conditions of Purchase.

Bidder is to detach and retain the General Bidding Instructions and Conditions of Purchase, Additional Conditions of Purchase, Scope and attachments from this form entitled "Bidder's Offer". Only this "Bidder's Offer" form is to be returned which offer shall incorporate by reference the General Bidding Instructions and Conditions of Purchase, Additional Conditions of Purchase, Scope and attachments.

**PLEASE SUBMIT FOUR (4) COPIES OF COMPLETED BIDDER'S OFFER FORM.**

Bids submitted as "acceptable alternates" should include detailed product or service literature, suitable for evaluation by the City. **IF THE MATERIAL, EQUIPMENT, OR SERVICE YOU INTEND TO OFFER HAS SIGNIFICANT VARIATIONS FROM THE SPECIFICATIONS STATED IN THIS INVITATION FOR BID, PLEASE READ PROVISIONS 13, 14, AND 15 OF THE GENERAL BIDDING INSTRUCTIONS AND CONDITIONS OF PURCHASE AND FOLLOW THE INSTRUCTIONS ACCORDINGLY.**

NOTE: The City of Phoenix has selected TNT Bestway Transportation as its preferred freight carrier through a competitive selection process. You may call TNT Bestway Transportation at 1-(800)-999-9489 to obtain rates for your transportation requirements. Though bidders are free to use any freight/transportation company, TNT Bestway is the City's preferred carrier of choice.

**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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The City will not be responsible for any Bidder errors or omissions.

This offer shall remain in effect for a period of 90 calendar days from the bid opening date and is irrevocable.

**COMPANY NAME**

Annex C – Invitation for Bid (IFB) for Traffic Signal Controller

CITY OF PHOENIX

Phoenix, Arizona

INVITATION FOR BID - IFB NO. xxxx
SUBJECT MATTER - TRAFFIC SIGNAL CONTROLLER
OPENING DATE AND TIME - xxxxxxxx

BIDDER'S OFFER (Continued)

3. SUBMITTALS (Continued)

3.1 BID PRICE AND DELIVERY SCHEDULE

NOTE:DO NOT INCLUDE ANY SALES, USE, OR FEDERAL EXCISE TAX IN YOUR BID. THE CITY IS EXEMPT FROM THE PAYMENT OF FEDERAL EXCISE TAX AND FOR BID EVALUATION PURPOSES WILL ADD SALES OR USE TAX AS APPLICABLE. THE CITY OF PHOENIX SALES TAX REFUND WILL BE CONSIDERED IN THE EVALUATION OF BIDS RECEIVED FROM BIDDERS LOCATED IN THE CITY OF PHOENIX.

VENDORS WITH MULTIPLE SALES OUTLETS IN THE LOCAL AREA, SHOULD SUBMIT THEIR BID RESPONSE THROUGH THEIR PHOENIX OUTLET, TO AVOID THE COST DISADVANTAGE ASSOCIATED WITH THE SALES TAX IMPLICATIONS.

Table with 6 columns: Item No., Manufacturer & Product No., Quantity, Unit Price Excluding Tax, Total Price Excluding Tax, Delivery Calendar Days ARO. Rows 1-3 show quantities of 120 each, 40 each, and 40 each.

Note item number 4 price to be reflected in items 1-3

Total bid

3.2 PAYMENT TERMS

Bidder offers a prompt payment discount of \_\_\_\_\_% \_\_\_\_\_ calendar days or \_\_\_\_\_% \_\_\_\_\_ PROXIMO (Select One), to apply after receipt of invoice or final

**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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acceptance of the products, whichever is later. If no prompt payment discount is offered, enter 0 in the % space to indicate net 30 days, otherwise payment terms shall be 2% 20 days, net 30 days; effective after receipt of invoice or final acceptance of the products, whichever is later. Payment terms offering less than 20 calendar days, either PROXIMO or regular, will not be considered in the price evaluation of your bid. Payment terms offering 20 calendar days or more, will be considered in the bid evaluation process.

**3.3 DELIVERY TIME**

All deliveries shall be made between the hours of 8:00 a.m. and 3:00 p.m., local time Monday through Friday, excluding holidays.

**3.4 DELIVERY SCHEDULE**

ITEM NO.	%	DELIVERY DAYS (CALENDAR)	CAN YOU MEET?		
			YES	NO	IF NOT, WHEN
1.	50%	120 Days ARO	_____	_____	
	50%	160 Days ARO	_____	_____	
2.	75%	120 Days ARO	_____	_____	
	25%	160 Days ARO	_____	_____	_____
3.	25%	120 Days ARO	_____	_____	
	75%	160 Days ARO	_____	_____	
4.	100%	120 Days ARO	_____	_____	

**COMPANY NAME**

CITY OF PHOENIX

Phoenix, Arizona

INVITATION FOR BID - IFB NO. Xxx  
 SUBJECT MATTER - TRAFFIC SIGNAL CONTROLLER  
 OPENING DATE AND TIME - xxxxxxxxxxxxxxxxxxxxx

BIDDER'S OFFER (Continued)

3. SUBMITTALS (Continued)

3.5 CERTIFICATIONS

In the event only one response is received, the City may require that the bidder submit a cost proposal in sufficient detail for the City to perform a cost/price analysis to determine if the bid price is fair and reasonable.

Bidder certifies it is a : proprietorship \_\_\_\_; partnership \_\_\_\_; corporation \_\_\_\_.

Arizona Sales Tax No. \_\_\_\_\_

Use Tax No. for Out-of-State Suppliers \_\_\_\_\_

City of Phoenix Sales Tax No. \_\_\_\_\_

Bidder certifies that he has read, understands, and will fully and faithfully comply with this invitation for bid, its attachments and any referenced documents. Bidder also certifies that the prices offered were independently developed without consultation with any of the other bidders or potential bidders.

Company's Legal Name  
\_\_\_\_\_

Address  
\_\_\_\_\_

City, State and Zip Code  
\_\_\_\_\_

Telephone Number  
\_\_\_\_\_

Company's Fax Number  
\_\_\_\_\_

Company's Toll Free Number  
\_\_\_\_\_

**Annex C – Invitation for Bid (IFB) for Traffic Signal Controller**

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Authorized Signature

\_\_\_\_\_  
Printed Name and Title

MAILING ADDRESSES (If different from above)

Purchase Order:

Name

\_\_\_\_\_  
Address

\_\_\_\_\_  
City, State and Zip Code

Payment Address: (If different from above)

Name

\_\_\_\_\_  
Address

\_\_\_\_\_  
City, State and Zip Code

**COMPANY NAME**

## **ANNEX D: PHOENIX ATMS REQUEST FOR PROPOSALS**

Unfortunately, the wording of the Phoenix ATMS RFP was not available in electronic format.

Please contact Joel Havris of the City of Phoenix Department of Transportation (602-262-6284 or [jhavris@ci.phoenix.az.us](mailto:jhavris@ci.phoenix.az.us)) for further details and/or a copy of the actual Phoenix ATMS RFP.

## **ANNEX E: TEST PLANS**

The project did not develop any written test procedures for either the central system or the traffic signal controllers. The testing was performed during integration testing with 'on-the-fly' tests.

Please contact Joel Havris of the City of Phoenix Department of Transportation (602-262-6284 or [jhavris@ci.phoenix.az.us](mailto:jhavris@ci.phoenix.az.us)) for further details.

## ANNEX F: THE NTCIP STANDARDS PROCESS

During the standards development process, all NTCIP standards progress from through a series of stages. These stages are described below:

- **Proposal** - someone submits an idea.
- **Working Draft** - The idea is reviewed in committee and goes through an iterative editing process.
- **User Comment** – When the Working Group reaches a reasonable level of consensus on the draft, it is submitted to the Joint Committee and upon their approval, it is distributed for user comments.
- **Recommended** - The Working Group has reached consensus on the document and the Joint Committee elevated the standard to this level by a 2/3rds vote . Typically, the Joint Committee also decides to send to ballot at this point.
- **Approved** - All three Standard Development Organizations balloted the standard, received enough affirmative votes, and have approved the document through their legal department, the standard reaches this level.
- **Published** - After a standard is approved, it then goes to the editorial group who is responsible for proper formatting and copyright statements. Once it is available in published form, the file is removed from the Web Site and the SDOs start charging a fee for it.